



Novel Nanoarchitected Cu₂Te as a Photocathodes for Photoelectrochemical Water Splitting Applications

Dong Jin Lee ¹, G. Mohan Kumar ¹, V. Ganesh ², Hee Chang Jeon ¹, Deuk Young Kim ^{1,3}, Tae Won Kang ¹ and P. Ilanchezhiyan ^{1,*}

¹ Quantum-Functional Semiconductor Research Center (QSRC), Institute of Future Technology, Dongguk University—Seoul, 04623 Seoul, Korea

² Department of Physics and Nanotechnology, SRM Institute of Science and Technology, Kattankulathur, Chennai 603203, India

³ Division of Physics and Semiconductor Science, Dongguk University—Seoul, 04623 Seoul, Korea

* Correspondence: ilanchezhiyan@dongguk.edu

1. Characterizations

The morphological characteristics of Cu₂Te samples are analyzed by scanning electron microscopy (SEM) (JEOL JSM-6380, operated at 15 kV) and high-resolution transmission electron microscopy (HRTEM). The phase purity and crystal structure of Cu₂Te NRs and vertical NSs was inferred through Panalytical XPert pro X-ray diffractometer with Cu-K α radiation (40 kV, 30 mA, $\lambda=1.5418$ Å). The Raman measurements were performed in a micro-Raman spectrometer using an excitation wavelength of 532 nm. The chemical composition of the Cu₂Te NRs and vertical NSs was obtained using X-ray photoelectron spectroscopy (XPS-PHI 660).

2. Photoelectrochemical studies

The photoelectrochemical properties Cu₂Te NRs and vertical NSs photocathodes were measured using CHI 200 potentiostat using a three electrode configuration. The VPE grown Cu₂Te NRs and vertical NSs on Cu foil were used as working electrodes, with Ag/AgCl and Pt as reference and counter electrode. All tests were measured in a 0.5 M Na₂SO₄ electrolyte. The photoresponse was measured under a continuous irradiation from a 300 W Xe lamp, and the visible light intensity were calibrated to 100 mW/cm² for the incidence onto the photocathode. The area of the photocathode exposed to light was 0.5 cm². The photoelectrochemical beaker was positioned 15 cm away from the xenon lamp. Photocurrent stability tests were carried out by measuring the photocurrent under chopped light irradiation at a fixed potential of 0 V vs. RHE. Before PEC measurement, the electrolyte was continuously bubbled with N₂ to remove oxygen and thus eliminate erroneous signals arising from oxygen reduction. Electrochemical impedance spectra (EIS) were measured with the frequency range from 0.1 Hz to 100 kHz under illumination. Mott-Schottky plots were acquired by sweeping the potential at fixed frequencies. Bode phase plots were measured in a frequency range between 0.1 Hz to 100 kHz at open-circuit voltage.

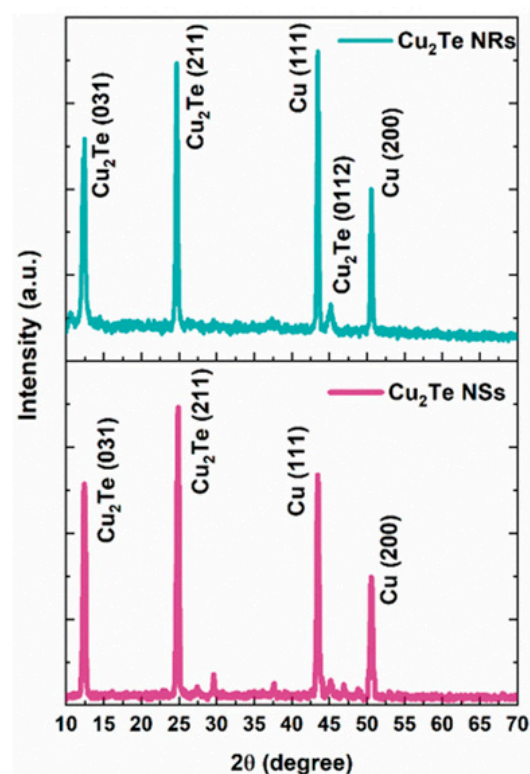


Figure S1. X-ray diffraction pattern of Cu₂Te NRs and vertical NSs after stability test.

Table S1. A comparisons of PEC performances of Cu₂Te photocathodes is given below.

Cu Based Photocathodes	Electrolyte	Maximum Photocurrents (mA cm ⁻²)	Reference
Cu _{2-x} Te/Cu layers	0.1 M NaNO ₃	0.014	[1]
Cu ₂ O/Cu foil	0.2 M K ₂ HPO ₄	0.47	[2]
Cu ₂ O-CuO	0.5 M K ₂ SO ₄	0.36	[3]
CuO-Cu ₂ O	0.1 M Na ₂ SO ₄	0.50	[4]
Cu-W Oxide	pH 11 NaOH	0.0010	[5]
Cu ₂ Te NSs/Cu foil	0.5 M Na ₂ SO ₄	0.53	This work

Table S2. Various parameters extracted from the equivalent circuit fit to the EIS data for Cu₂Te NRs and NSs photocathodes in 0.5M Na₂SO₄ electrolyte solutions.

Samples	R _s (Ω)	R _{ct} (Ω)	W _z (Ω)	C _μ (μF)	χ ² × 10 ⁻⁴
Cu ₂ Te NSs	33.74	1075	0.38	15.47	5.8
Cu ₂ Te NRs	21.65	2673	0.12	39.11	3.8

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